NO. REKOD: PPSP-B-ADK-13

UNIVERSITI SAINS MALAYSIA

**GRADUATE SCHOOL OF BUSINESS (GSB)**
**UNIVERSITI SAINS MALAYSIA**

## DECLARATION

I hereby declare that the project is based on my original work except for quotations and citation which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at USM or any other institutions.

(Signature):

Name: Setareh Monsefi

Date: 23/12/2013

# THE MEDIATING EFFECT OF OVERALL SATISFACTION ON RELATIONSHIP BETWEEN INDOOR ENVIRONMENTAL QUALITY AND WORK PERFORMANCE: EVIDENCES FROM OCCUPANTS OF GREEN BUILDINGS IN MALAYSIA

By

SETAREH MONSEFI

Research report in partial fulfillment of the requirements for the degree of Mater of Business Administration (Sustainable Development)

Universiti Sains Malaysia

October 2013

## DEDICATION

...to my beloved husband, Mohamadreza Hamzavi, who gives me drive to tackle any task with enthusiasm and determination; my respective parents, Akbar Monsefi and Manijeh Rezaie, who are my constant sources of inspiration; my sister and twin brother, Sara and Mohamadreza Monsefi who have never left my side and are very special to me.

## ACKNOWLEDGMENT

I have taken efforts in this project. However, it would not have been possible without the kind support and help of many people. I would like to extend my sincere thanks to all of them.

First this research project would not have been possible without the support of my supervisor, so I would like to express my gratitude to Associate Professor, Dr. Azlan Amran, Deputy Dean (Academic) who was abundantly helpful and offered invaluable assistance, unreserved support and guidance. I am also so grateful to my co-supervisor, Dr. Yudi Fernando who provided me with irreplaceable assistance, especially with SmartPLS software along with his support and help. I am highly indebted to them for their guidance, attention to details, and for providing necessary information, and for their support in completing this management project.

Deepest gratitude are is also due to the Dean of Graduate School of Business, Associate Professor Dr. Sofri Yahya, and also all administrative support members of the school for their support, and due to the IPS (Institute of Postgraduate Studies) in USM, and the respectful Assoc Prof Krishna Swamy Jayaraman for arranging the PLS workshop for students.

Most importantly, I should deeply thank my wonderful husband, who has supported me throughout entire process, both by keeping me harmonious and helping me putting pieces together. I will be grateful forever for his love, support and sacrifice that made it possible for me to go through and complete this journey to accomplish my

management project, and helping me to maintain perspective and balance in my study and life. I would also like to acknowledge my gratitude to my kind parents and parents-in-law for their kindness, love and support.

My gratitude is also due to my examiners for their constructive comments and feedbacks which help me to improve my management project.

Moreover, I would like to thank my friend Dr. Elham Rahbar, who helped me with her valuable guidance and support, her concern, friendship and laughter who helped me to ease my stress at times during my journey. I would also like to acknowledge my friends Alison and Peter Hayes, who helped me to improve my English level of thesis writing, and my friend Nur Aulia Fahada bt Misaridin, for helping me to translate the abstract section of my thesis to Bahasa Malaysia. Furthermore, I would like to thank all kind respondents who replied to my online questionnaire.

# TABLE OF CONTENTS

**Title** **Page Number**

## List of Tables

**Title** **Page Number**

## List of Figures

**Title** **Page Number**

# ABSTRAK

Bangunan-bangunan telah dikenalpasti sebagai faktor penyumbang kepada pengurangan perubahan iklim, dan bangunan hijau yang lestari membawa kepada penggunaan tenaga dan sumber yang cekap seiring dengan persekitaran yang selesa, sihat dan produktif yang disediakan kepada para penghuni. Sejak dua puluh tahun yang lepas, bilangan bangunan-bangunan pejabat di kesemua bandar-bandar utama semakin meningkat terutamanya di Kuala Lumpur dan semenjak 2009, apabila Indeks Bangunan Hijau Malaysia telah memperkenalkan garis panduan bagi memperoleh pensijilan bagi bangunan hijau yang lestari, terdapat peningkatan di dalam pembinaan bangunan-bangunan hijau di Malaysia bagi kediaman dan bukan kediaman. Penyelidikan ini bertujuan untuk mengkaji hubungan di antara kepuasan para pekerja dengan lima kriteria bagi persekitaran dalaman yang berkualiti (IEQ) di ruang kerja mereka, kepuasan mereka dengan keseluruhan pejabat, dan prestasi kerja mereka serta meneliti kesan kepuasan para pekerja ke atas prestasi mereka dan juga kesan pengantaraan bagi keseluruhan kepuasan ke atas hubungan di antara kriteria-kriteria IEQ dan prestasi kerja para pekerja dengan membina dan menguji kerangka penyelidikan yang menunjukkan hubungan di antara pembolehubah-pembolehubah ini.

Analisis data sekunder telah digunakan untuk mengkaji tujuan penyelidikan ini di mana data telah diperolehi daripada maklumbalas oleh penghuni-penghuni di lima bangunan hijau melalui soal selidik dalam talian dan 112 responden telah dikumpul untuk analisis data. Daripada analisis data berstruktur menggunakan analisa laluan PLS, ia menunjukkan bahawa kepuasan terhadap kelima-lima kriteria persekitaran dalaman yang berkualiti iaitu kualiti bagi pengudaraan dalaman, arus udara panas, pencahayaan, visual dan akustik mempunyai pengaruh yang ketara ke atas keseluruhan kepuasan pekerja dengan persekitaran pejabat. Hanya kepuasan dengan kualiti pencahayaan mempunyai kesan positif yang ketara ke atas prestasi kerja pekerja. Terdapat hubungan yang ketara antara keseluruhan kepuasan pekerja dengan persekitaran pejabat secara menyeluruh dan prestasi kerja mereka. Walau bagaimanapun, ujikaji ke atas kesan pengantaraan bagi keseluruhan kepuasan pekerja di dalam hubungan di antara lima kriteria persekitaran dalaman yang berkualiti, dan prestasi kerja pekerja menunjukkan bahawa keseluruhan kepuasan tidak mempunyai kesan pengantaraan hanya di dalam hubungan antara kepuasan pekerja dengan kualiti pencahayaan and prestasi kerja pekerja.

# ABSTRACT

Buildings are recognized as a key contributor to the climate change mitigation, so they have been receiving increased attention in recent years in terms of design, performance and evaluation. Sustainable green buildings can deliver energy and resource efficiency, along with providing a comfortable, healthy and productive environment for occupants. Office buildings in all major cities of Malaysia have increased considerably in numbers, especially in Kuala Lumpur over the last twenty years, and since 2009 that the Malaysia Green Building Index introduced guidelines for acquiring certifications for sustainable green buildings, there has been a growing numbers of green buildings constructed in Malaysia in both forms of residential and non-residential. This study examined the relationships between employees' satisfaction with five indoor environmental quality (IEQ) criteria at their workspaces, their overall satisfaction with the whole office, and their work performance, along with examining the effect of employees' overall satisfaction on their work performance, and the mediating effect of overall satisfaction on the relationship among IEQ criteria and employees' work performance, by developing and testing a conceptual framework demonstrating relationships among these variables. The five IEQ criteria investigated in this study include indoor air quality, thermal quality, lighting quality, visual quality and acoustic quality

Secondary data analysis was used to investigate the purpose of this study in which data were obtained from online questionnaire replies of five green building occupants (employees), and a total of 112 respondents were collected for data analysis. From the structural model analysis using the PLS path analysis, it was found that satisfaction with all five indoor environmental quality of indoor air, thermal, lighting, visual and acoustic quality significantly influenced employees' overall satisfaction with office environment. While only satisfaction with lighting quality had positive significant effect on employees' work performance. There was significant relationship among employees' overall satisfaction with the whole office environment and their work performance. However, testing the mediating effect of employees' overall satisfaction on relationship between five indoor environment quality criteria, and employees' work performance revealed that overall satisfaction did not have mediating effect on relationship between employees' satisfaction with lighting quality and employees' work performance.

# CHAPTER ONE: INTRODUCTION

## 1.0. Introduction

Due to the environmental issues such as climate change, global warming, ozone layer depletion, air pollution and water pollution which have been worsening, and arising from everyday growing population of the world, there have been many rules, guidelines, and requirements developed, along with the certifications and assessment criteria helping to protect the environment. As a result, business corporations and organizations are encouraged to, and sometimes obliged to follow the requirements, and consequently obey the existing rules in whatever area their business is. For instance, businesses inevitably need a working environment, known as offices, and offices are basically located in buildings. Employees who are occupants of these office buildings can be affected by the office conditions they work in. So, business owners can choose the extent to which their office building is compliant with sustainability requirements, rules and guidelines to contribute to environment protection.

The purpose of this study is to investigate occupants' satisfaction with Indoor Environmental Quality (IEQ) components including: indoor air quality, thermal quality, lighting quality, visual quality and acoustics quality in sustainable or "green" buildings, certified by the Malaysia GBI (Green Building Index) rating system through findings from questionnaire, and the effect of Indoor Environmental Quality (IEQ) on their overall

satisfaction with the office condition, and also on their work performance. The mediating effect of occupants' overall satisfaction on relationship between Indoor Environmental Quality and Occupants' work performance is going to be investigated as well.

## 1.1. Background of the Study

Following the Rio Earth Summit, United Nation Conference on Environment and Development (UNCED), in June 1992, world crisis of ozone depletion, climate change, greenhouse gas emission, and scarcity of resources due to their overconsumption, became familiar for nations (http://www.johannesburgsummit.org). In the matter of environmental conservation and sustainability, the building industry plays an important role, because buildings and their associated construction activity account for at least 30% of the world greenhouse gas emissions, and almost 40% of the consumption of raw materials and energy according to the Royal Institute of Chartered Surveyors (RICS) in 2005 (Eichholtz, Kok & Quigley, 2009). Buildings consume about 40% of all primary energy (Masoso & Globler, 2010), therefore an effective way to diminish negative effects of climate change is to reduce buildings' energy consumption (Yun, Kong, Kim & Kim, 2012).

By realizing the fact that buildings have significant negative contribution to the greenhouse gas emissions, and energy and resource consumption, the need for re-designing the buildings which are more sustainable, known as "Green Buildings" initiated. In fact, for attaining considerable energy conservation, and reduction in greenhouse gas emissions, communities can benefit from a great opportunity which lies

in creating a sustainable approach for designing, constructing and developing buildings to protect the natural environment, at the same time, to even enhance it. Office buildings should consume less energy to contribute in reducing greenhouse gas production as part of the effort to preserve natural environment. Large amounts of energy can be saved for instance by using proper lighting in addition to taking advantage of natural light available. However preferred lighting levels are varied for different persons, and desired amount of additional electric light varies depending on the type of employees' task and their distance from the window (Galasiu & Veitch, 2006).

### *1.1.1. Impact of Buildings on Environment*

Green building is a growing basis for higher level of performance that helps to create more sustainable built environments which have minimal impact on natural environment and human health. The movement strives to accomplish this goal by making a permanent shift in prevailing design, planning, construction, and operation practices using resource efficient and environmental responsible processes and materials. (U.S. Green Building Council, 2011). Buildings are receiving increased attention in recent years in terms of design, performance and evaluation, since they have been recognized as a key contributor to the climate change mitigation (Brown, 2009).

Therefore, reductions in environmental damage, as well as enhancement in people's health and their satisfaction, are opportunities that can be gained by designing, planning, and construction of green or sustainable buildings which have improvements in working environment as one of the requirements in offices. Buildings have a significant

negative impact on the environment and human health due to the resources, energy, materials and water needed and consumed to create and operate the buildings. For instance, wildlife habitat might be destroyed in order to clearance of land for development, air and water might be polluted as a result of extraction, manufacturing and transportation of materials that contribute to toxic chemicals release and greenhouse gas emissions. Large amount of waste can be produced and substantial amount of water and energy is consumed during building operation process. According to U.S. Green Building Council (2011) in the United States, buildings account for 14% of potable water consumption, 30% of waste output, 40% of raw materials use, 38% of carbon dioxide emissions, 24% of energy use, and 72% of electricity consumption.

On the other hand, buildings which are constructed according to sustainability requirements, such as green buildings, can contribute to efficient use of resources like land, electricity and water which result in some direct cost savings; and can also minimize pollution which helps to reductions in environmental externalities. Furthermore, green building can bring about indirect gains from positive effects on its occupants through improvements in indoor environmental quality, such as chemical reductions and enhanced indoor air quality in offices (Huang, 2009; Heerwagen, 1998).

### *1.1.2. Guidelines in the Building Industry*

In order for green buildings to reach these goals, there should be guidelines and rating systems according which these sustainable buildings can be designed, constructed and evaluated. As a result, the Green Building ratings was first introduced in UK in 1990

with BREEAM (Building Research Establishment Environmental Assessment Method), and later in USA with LEED (Leadership in Energy and Environmental Design), in Australia with Green Star, in Singapore with Green Mark, and in Malaysia with Green Building Index. LEED for example, has been developed by the U.S. Green Building Council (USGBC), a community to promote and encourage green building, founded in 1992. These green rating tools are dependent upon location and the climate, for example Green Building Index (GBI) developed by PAM (Pertubuhan Arkitek Malaysia / Malaysian Institute of Architects) and ACEM (the Association of Consulting Engineers Malaysia) in 2009, specifically for Malaysia tropical climate.

These rating systems recognize and categorize significant assessment criteria regarding building performance, human and environmental health that have to be taken into consideration during the procedure of designing, constructing, operating and even maintaining buildings. These factors basically include site, energy, water, materials, and indoor environmental quality (IEQ), but with some minor differences among varied rating systems. IEQ is the focus of this study amongst these factors. Figure 1-1 illustrates the comparison of assessment criteria between GBI Malaysia and other recognized green building certification schemes, according to Hwa (2009) by referring to the PAM and ACEM Green Design Forum (2009).

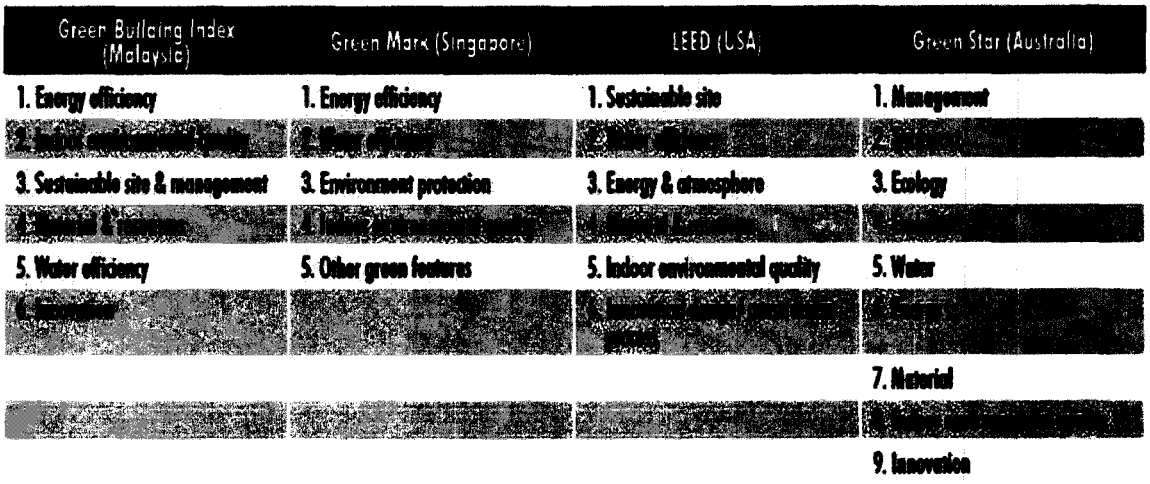


Figure 1-1. Comparison of assessment criteria between GBI Malaysia and other recognized building certification schemes, adopted from Hwa (2009)

### *1.1.3. Green Building in Malaysia*

Hyper urbanization is one of the local issues that Malaysia encountered today. By 2030 its urban population is expected to grow by 40-50% and consisting 70-80% of total population, therefore, in order to move forward toward sustainable future, the way Malaysia's cities are planned is a key component of the country's sustainability path (Green Building Index, 2010). Besides, Malaysia has the highest per capita energy consumption among ASEAN countries, while by 2015, this country will become a net importer of energy, and these issues should be reflected in the way buildings are designed in the country and how much energy they need to be run. Apart from local issues stated above, Malaysia is facing global issues, such as being a signatory to the Kyoto Protocol for tackling the problem of climate change, heavy dependence on non-renewable energies which are profoundly declined contrary to Malaysia's renewable energies. Electric power stations of the country are increasingly dependent on imported coal, and these issues

show the necessity of constructing sustainable buildings which are more energy efficient and relied on renewable energies (Jallendran, 2010). Malaysia aims at reaching the status of a developed country by the year 2020, and the building industry is considered as a main catalyst for this goal to be achieved (Abidin, 2010). Nonetheless, this industry also negatively contributes to destructive impact on the environment such as depletion of natural resources, soil erosion and sedimentation, and the use of construction materials which are harmful to the human health (Construction Industry Development Board Malaysia (CIDB), 2007). Therefore the challenge that the construction sector is faced, is to be able to respond to the need for adequate housing and rapid urbanization, while doing it in a way that is socially and ecologically responsible (Du Plessis, 2007), and this was insisted by the fifth Prime minister of Malaysia: Malaysia developers should make sure that the environment is not sacrificed for the sake of development (Chin, 2005).

Due to the global problems of greenhouse gas (GHG) emission and ozone depletion, some nations like UK and USA realized that by re-designing buildings and built environments, negative impacts of buildings on the environment would be reduced, since they significantly contribute to GHG emissions. Following that, the notion of green buildings; and then their rating systems were introduced in 1990s, which BREEM (UK), and LEED (USA) are the pioneers and better known ones among the others. In Malaysia in 2008, the need for a localized green building rating tool became more apparent. It was in line with increasing demands from building end-users for green-rated buildings, that essentially have very low impact on the environment, and consistent with organizations' growing trend toward good corporate social responsibility (CSR) to support environment-friendly initiatives for their offices. Therefore, PAM (Pertubuhan Akitek Malaysia)

Council whose architects have been working years toward a more green and sustainable architecture, approved the formation of the new sustainability committee in August 2008. They developed the Green Building Index Malaysia that was officially launched in April 2009, along with the Panel for certifying and accreditation of Green rated buildings (Mun, 2009). With PAM contribution, Malaysia could develop over 60 million square feet of green building in four years since the date GBI was launched (www.greenbuildingindex.org, 2013).

The green buildings save energy and resources, recycle materials, and minimize the emission of toxic substances throughout their life cycle; harmonize with the local climate, culture, traditions and their surrounding environment; and are able to sustain and improve human life quality whilst maintaining ecosystem capacity at local and global levels. Furthermore, green buildings have economic benefits of better utilizing resources, considerable operational savings, and improved workplace productivity. Besides, organizations that choose sustainable buildings as their offices, can enhance their company image for being more responsible, and committed to the future generation. With regards to the policies, Malaysia has been involved with international agreements such as Rio in 1992, Local Agenda 21 of Kyoto Protocol in 2000, and recently in 2009, COP 15 Copenhagen Accord (United Nations Climate Change Conference at Copenhagen) as it is demonstrated in Figure 1-2.

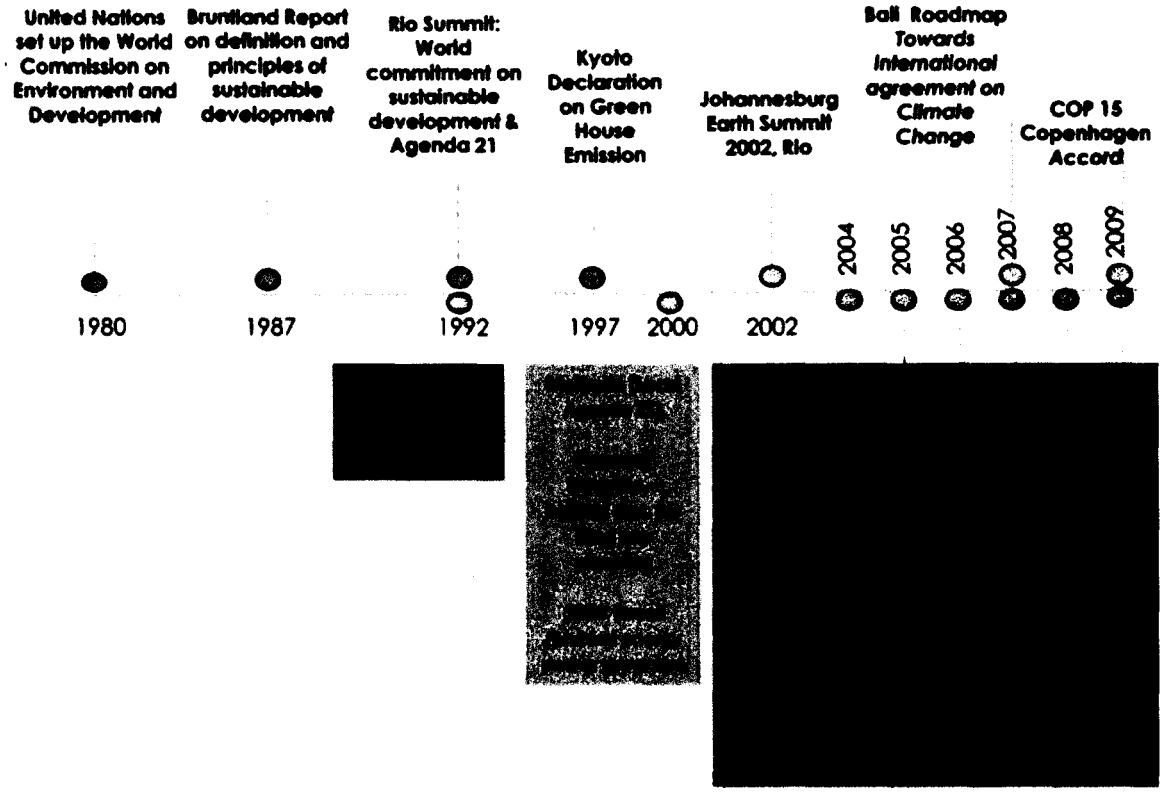


Figure 1-2: Malaysia involvement with international agreement, adopted from Harn (2013).

Since 2009 that the Malaysia Green Building Index introduced guidelines for acquiring certifications for sustainable green buildings, there has been a growing numbers of green buildings constructed in Malaysia in both forms of residential and non-residential. Business owners are getting more aware of the effects of healthier environment of offices in green buildings on employees' comfort, health, satisfaction and their productivity and are getting more inclined to choosing their offices in green buildings. As it is depicted in Figure 1-3, there has been a transformation in governance

in order to encourage green policies in Malaysia since 2009: *KeTTHA*, the Ministry of Energy, Green Technology and Water was restructured from the old ministry; Income Tax Exemption for GBI certified buildings, *Green Tech Malaysia* was set up as the implementation arm for KeTTHA; *SIRIM* an accredited certification, inspection and testing services had started its eco-label scheme; *SEDA* (Sustainable Energy Development Authority of Malaysia) was established and actively pushing for solar power through its various programs; *Suruhanjaya Tenaga* also began Energy Efficiency labeling, which are all push factors for the Green Building Industry of Malaysia (Harn, 2013).

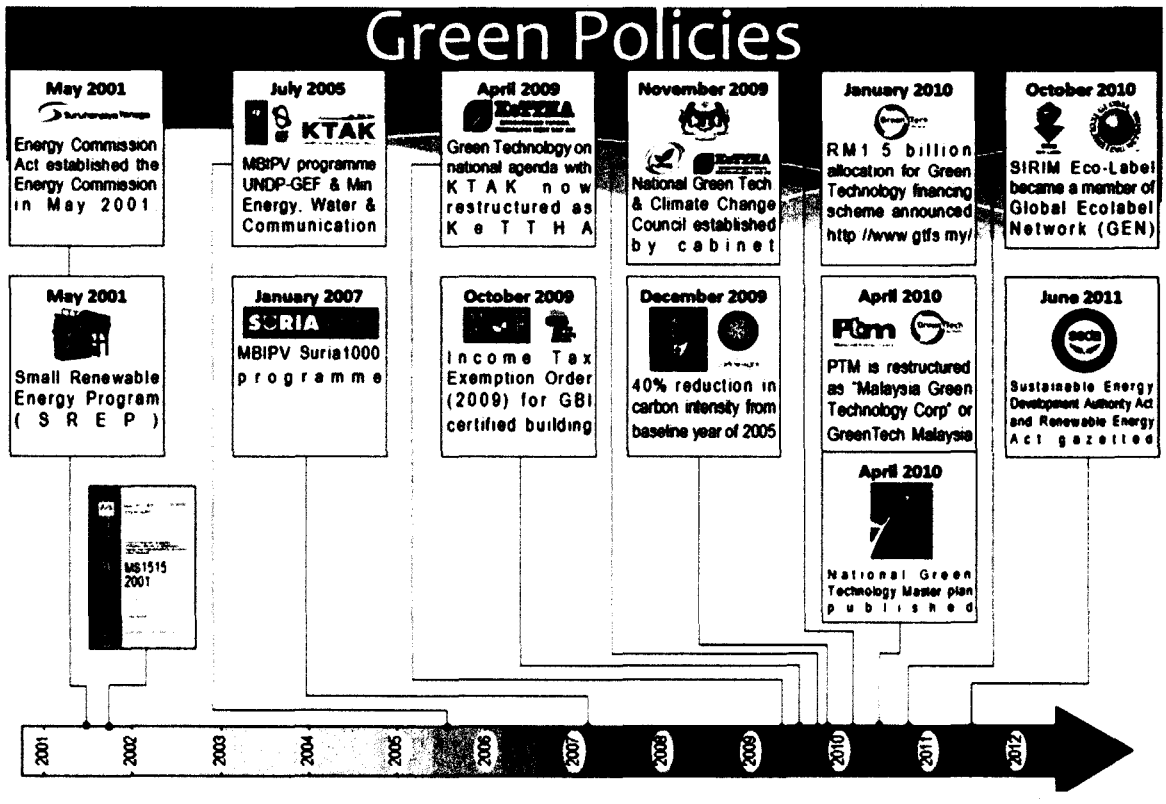


Figure 1-3: Green Policies of Malaysia, adopted from Harn (2013).

Green building or sustainable construction concept governs three main pillars of sustainability including environmental protection, social well-being, and economic prosperity, which the first one, environmental protection concerns the impacts of built environment on natural environment which includes extraction of natural resources. Social well-being is concerned with concepts like human feelings, perceptions of safety, security, comfort and satisfaction. And the last one, economic prosperity concerns the monetary gains and benefits from the projects for the clients and other playes in the building industry (Harn, 2013). In a study done by Abidin (2010) from School of Housing, Building and Planning in USM (Universiti Sains Malaysia) who investigated the understanding towards sustainable construction concept by Malaysian developers, it was found that majority of respondents considered themselves as having moderate to good knowledge regarding sustainable construction concept. Figure 1-4, on next page, shows the level of understanding of Malaysia developers on sustainability concept based on Abidin (2010) study.

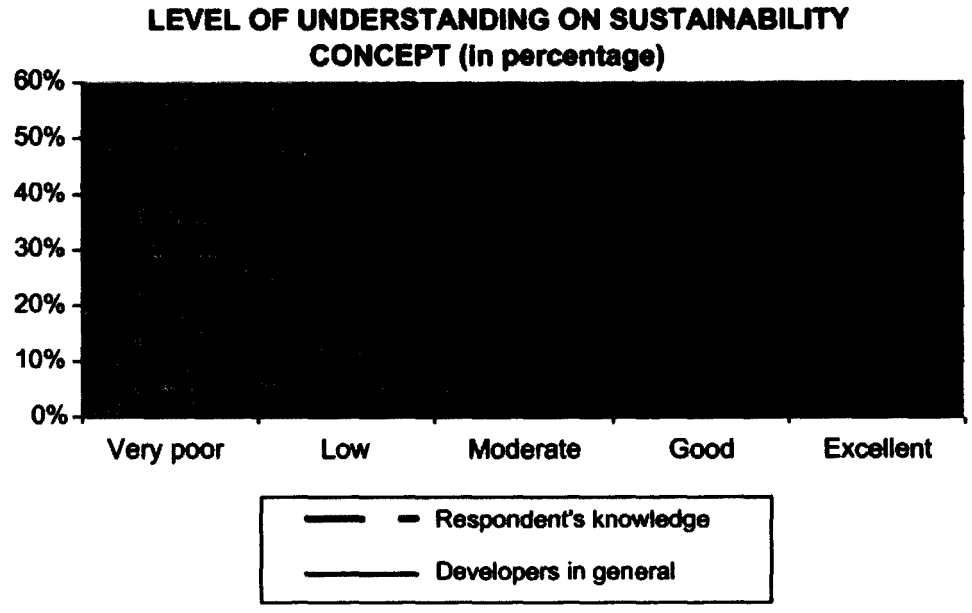


Figure 1-4. Level of Understanding of Malaysian Developers on Sustainability Concept, adopted from Abidin (2010)

In Abidin (2010) survey, respondents were required to choose among statements which best describe their understanding about sustainable construction concept. The results are demonstrated in figure 1-5. It is good to note that those issues that are associated with environmental aspects of sustainability received the highest percentage, like effective protection of the environment with 89%, effective environmental planning, management and control with 80%, and prudent use of natural resources with 69%. While issues related to social aspects of sustainability received moderate percentages, including: enhanced quality of life and customers' satisfaction with 71%, and social progress which recognize the need of everyone with 43%. And finally, the issues associated with economic aspects of sustainability received lowest percentages including; generating profit without compromising future needs with 43%, and maintenance of high

and stable levels of economic growth with 49%. Overall, it shows that although majority of Malaysian developers understand that sustainability and green building are about protecting the environment, many are still unaware that they are also about balancing social and economic aspects of construction. Abidin (2010) sees the findings not surprising, since he justifies that Malaysia government and professional bodies' efforts are mostly focused on enhancing environmental awareness.

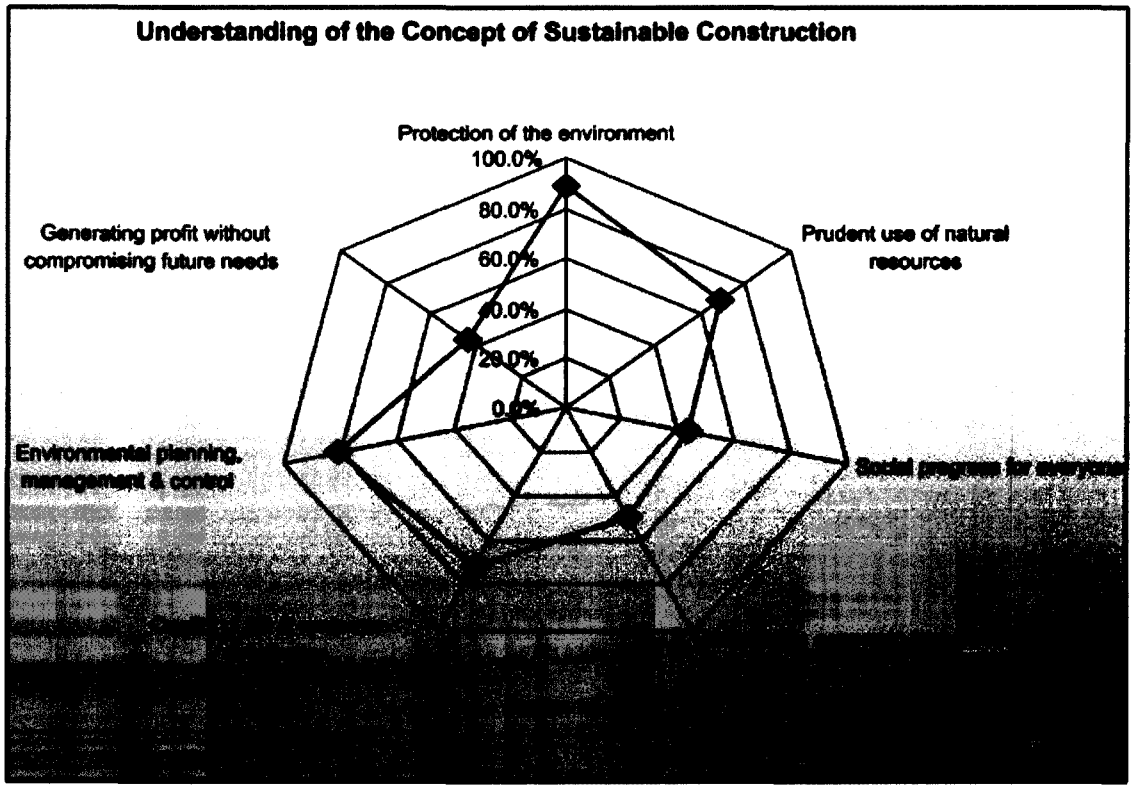


Figure 1-5: Malaysian Developers' Awareness on the Concept of Sustainability in Construction, adopted from Abidin (2010).

## 1.2. Problem Statement

From the statistics released by the U.S. Environmental Protection Agency (EPA) (2009), people spend approximately 90 percent of their time inside buildings. This exceptional amount of time spent indoors by humans creates the necessity of a healthy and safe built environment in which materials, finishes, and products do not endanger the occupants' health, as these materials can have negative effects on indoor environmental quality of the workspace (Freihoefer, 2012).

Work life quality of employees, their level of satisfaction and working performance are significant factors for economic success of businesses, and business organization owners have been informed of the importance of recognizing specific criteria in designing and constructing indoor working environment of employees which have effect on their perceived satisfaction and working performance (Lee, 2007). Buildings' indoor environment can have negative impacts on occupants' health, comfort and productivity: Noise and inappropriate temperature may result in stress symptoms and irritability. Poor condition of lighting can produce glare on the computers with which occupants are working, and may cause headache and eye problems. Poor indoor air quality can be result of air borne toxins and noxious chemicals existence in the indoor environment. Overall, negative impacts of building indoor environments might include discomfort, illness, fatigue, stress, absenteeism and distractions which can be due to poor indoor air quality, lighting, thermal condition, and specific aspects of interior space design such as furnishing and materials selections.(US Department of Energy EERE, 2006; Heerwagen, 1998). In addition, employees' absenteeism, discomfort and poor performance are too costly to the organizations. Managers try to control these critical

factors to avoid any further cost incurred. In green buildings, IEQ (Indoor Environmental Quality) criteria in any rating systems emphasize on improving the indoor environment quality to inhibit or eliminate problems of discomfort, dissatisfaction, and poor performance. Therefore, Indoor environmental quality (IEQ) is considered as one of the important factors with rather high credits. This category encompasses the conditions inside a building such as lighting, air quality, ergonomics and thermal comfort as well as their effect on residents or occupants. (US Green Building Council, 2011)

On the contrary, creating a satisfying working environment for employees-as building's occupants- improves their satisfaction and working performance (Vischer, 2007; Wyon, 2004; Charles & Veitch, 2002). Nonetheless, in spite of efforts of architects, designers, builders, and constructors of green and sustainable buildings, some studies have revealed that occupants of these buildings are not always satisfied with all criteria of IEQ at their workspaces, and their perceived work performance is not enhanced with regard to IEQ criteria of their working environment comparing to conventional buildings (Turner, 2006). Factors like privacy and acoustic conditions for instance, are not very satisfying in green buildings from occupants' point of view, and they usually have complaints about noise and lack of privacy, which will be discussed in detail later in literature review chapter.

Moreover, as was discussed in section 1.1.3 of this chapter, studies revealed that Malaysia developers' understanding regarding sustainable construction is weak, and they mostly associate it with environmental protection, while social well-being and end-user satisfaction is rated second, followed by economic benefits (Abidin, 2010).

Furthermore, a lot of research has been done on comparing GBI Malaysia rating to the US LEED and Singapore Green Mark. And although several studies have been done to assess the relationships between IEQ criteria of green buildings with occupants' health and well-being, satisfaction and performance; very few studies have been done in Malaysia to investigate the effect of green-certified buildings by the GBI Malaysia on occupants' perceived performance and satisfaction. One research investigated the effect of indoor environmental quality on occupant's perception of performance on refurbished historic buildings in Malaysia (Kamaruzzaman et al, 2011). The other study was examined post occupancy evaluation towards indoor environment improvements in Malaysia's office buildings (Khalil & Husin, 2009), and recently Kamali & Abbas (2012) done a study investigating effect on nurses' quality services in a healthcare center in Putrajaya, Malaysia, through proper lighting design, but none of them studied on green buildings. So, there is lack of study to assess the influence of IEQ (Indoor Environmental Quality) criteria at occupants' workspaces in green buildings in Malaysia, on their satisfaction with overall office conditions, as well as on their perceived working performance. Moreover, examining occupants' satisfaction with IEQ criteria and its effects on their performance has been described in studies done by research centers like Center for Built Environment (CBE) at University of California, Berkeley. Nonetheless, little has been conducted to examine how employees' perception with specific IEQ criteria at their workspace is related to their satisfaction with the whole office environment they are working, and simultaneously to their work performance. Furthermore, considering the importance of employees' perceptions of the quality of indoor environment they are working (workspace and office), it is important to examine

whether employee's satisfaction with their working environment has effect on their work performance, and whether having overall satisfaction with the whole office environment mediates the relationship between employees' perception with IEQ criteria at their workspaces, and their work performance. Little research has been conducted to investigate the simultaneous relationships and interactions between employees' satisfaction and work performance, and IEQ criteria of green buildings at workspaces and offices.

## 1.3. Research Objectives

The Purpose of this study is to examine the relationship between green building's *Indoor Environmental Quality* and occupants' *satisfaction with their office environment*, and also occupants' *work performance* in Malaysia. Besides examining the effect of occupants' satisfaction with the overall office environment on their perceived work performance is another objective of this study. IEQ criteria surveyed in this study includes indoor air quality, thermal quality, lighting quality, visual quality and acoustic quality which are derived from the Malaysia Green Building Index Assessment Criteria for Non-Residential Existing Buildings and Non-Residential New Construction (NREB and NRNC) (2013). Non-residential category is chosen for the purpose of this study, since the office buildings are of this classification, not residential type. To make it more clarified, this research aims at studying whether satisfaction of green building occupants with "air quality" for example in their workspaces, has effect on their *overall satisfaction with the office environment,* also has effect on their perceived *work performance.* Besides, it aims at examining whether occupants' *overall satisfaction with the office*

*environment* have relationship with their *work performance*, and whether occupants' overall satisfaction have *mediating effect* on relationship between IEQ at workspaces, and occupants' work performance.

For the research objectives to be accomplished, a questionnaire was designed, by adapting the Post Occupancy Evaluation (POE) created by CBE (Center for Built Environment) of University of California, to investigate whether IEQ criteria leads to green building occupants' overall satisfaction with their working environment in Malaysia, whether it enhances their work performance, and whether their overall satisfaction have relationship with their work performance, and has mediating effect. But first a hypothesized relationship among variables of this study is going to be proposed in order to investigate the stated relationships.

Therefore objectives of this research study, within a green building setting are as follows:

1. To investigate influence of occupant satisfaction with *each IEQ criteria** at their workspace on their *overall satisfaction with office condition*.
2. To investigate influence of occupant satisfaction with *each IEQ criteria** at their workspace on their *work performance*.
3. To examine the relationship between occupants' *overall satisfaction with office condition*, and their *work performance*.
4. To examine whether occupants' *overall satisfaction with office condition* mediates the relationship between satisfaction with *each IEQ criteria** at workspaces, and occupants' *work performance*.

**Indoor Environmental Quality criteria include air quality, thermal quality, lighting quality, visual quality and acoustic quality.*

It should be noted that the terms "workspace" and "office" both refer to the working environment for employees: workspace is a smaller personal space for working, while office is the bigger working environment as a whole.

## 1.4. Research Questions

According to the research objectives of this study, the research questions are as follow:

1. Does satisfaction of green building occupants with *IEQ criteria** at their workspace have significant influence on their *satisfaction with overall office condition*?
2. Does satisfaction of green building occupants with *IEQ criteria** at their workspace have significant influence on their *work performance*?
3. Is green building' occupant *overall satisfaction with office conditions* significantly related to their perceived *work performance*?
4. Is green building occupants' *overall satisfaction with office condition* mediating the relationship between *IEQ criteria** at workspaces, and their *work performance*?

**Indoor Environmental Quality criteria include air quality, thermal quality, lighting quality, visual quality and acoustic quality.*

## 1.5. Definition of key terms

This section describes the concepts that introduced earlier in this chapter, including Green Building, U.S. Green Building Council (USGBC), Leadership in Energy and Environmental Design (LEED), Green Building Index (GBI) rating system of Malaysia, and Indoor Environment Quality (IEQ).

### 1.5.1. Green Building

USGBC defines green building as a process which applies to buildings, their sites, their interiors, their operations, and the communities in which they are situated. This process flows throughout the entire lifecycle of a project: beginning at the inception of a project idea and continuing seamlessly until the project reaches the end of its life, and its parts are recycled or reused (www.epa.gov). Karolides (2011), a member of American Institute of Architects describes green building as a way of enhancing the environment: "Done right, it benefits human well-being, community, environmental health, and life cycle cost. This means tailoring a building and its placement on the site to the local climate, site conditions, culture, and community in order to reduce resource consumption, augment resource supply, and enhance the quality and diversity of life." (p.3)

Green and sustainable buildings conserve natural resources by more and more relying on renewable resources instead of non-renewable resources, use rain harvesting, consume energy and water efficiently, use non-toxic and recycled building materials as well as providing recycling and waste demolition facilities, maintain good indoor air

quality, preserve natural vegetation, capture natural lighting, allow for flexible interiors and provide public transportation for occupants comfort. (Jallendran, 2010)

### 1.5.2. U.S. Green Building Council (USGBC)

USGBC is a non-profit organization, formed in 1992 in USA, to promote and encourage green buildings. The USGBC community engages hundreds of thousands of individuals, and its mission is "to transform the way buildings and communities are designed, built and operated, enabling an environmentally and socially responsible, healthy and prosperous environment that improves the quality of life" (US Green Building Council, 2011). USGBC supports achievement of this mission through programs, advocacy, research, an extensive network of local chapters, and the Leadership in Energy and Environmental Design (LEED). LEED standards include five major categories, and each one has a specific number of points and credits assigned for the building assessment. The five major categories are: Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, and finally Indoor Environmental Quality (IEQ) which is the focus of this study.

Each building earns total points according to these five LEED assessment criteria, and will be accredited for one of the four levels of green buildings depending on the scores obtained, from highest to lowest respectively for: Platinum, Gold, Silver, or Certified.

U.S Green Building Council argues that there has been a successful market change in green building movement from public building sector to the private sector, due to the fact that among building development projects that seek for LEED certification, majority

of them are commercial office projects. In other words, business managers have been increasingly asking about the relationship between the work environment of these green buildings-which is related to Indoor Environmental Quality criteria- and their employees' satisfaction and performance (www.wbdg.org). This shift raised the vital economic issue, and made IEQ become a significant concern among five categories of LEED criteria. Because business managers need to know whether Indoor Environmental Quality criteria of green buildings can contribute to their employees' satisfaction and performance, and consequently to the long-term financial return on investment generated from improved occupants' perception of satisfaction and productivity.

USGBC believes that since building occupants spend majority of their time indoors, IEQ can directly affect occupants and their perceptions, and that is why Research Committee of USGBC has found this area very critical which needs further study. Therefore, the ultimate success of a sustainable building design depends on the subsequent IEQ (Indoor Environmental Quality) of the completed building (Whole Building Design Guide, 2012).

### 1.5.3. Leadership in Energy and Environmental Design (LEED)

The green building movement is being leaded by the LEED in U.S, which its standards' popularity continues to grow, and its creation is a national response to the enhancing social awareness about negative impacts that buildings have on the environment, such as depletion of natural resources, waste production, increased energy consumption, and growing reported incidences of the negative health impacts such as sick building syndrome (SBS) caused by IEQ problems. (Lee & Guerin, 2009)

LEED is defined as a third-party certification program and the nationally accepted benchmark for the design, construction and operation of high performance green buildings. The rating systems give building owners and operators the tools they need to have an immediate and measurable impact on their buildings' performance. LEED by recognizing performance in location and planning, sustainable site development, water savings, energy efficiency, materials selection, indoor environmental quality, innovative strategies, and attention to priority regional issues, could promote a whole-building approach to sustainability. Additionally, LEED addresses all building types through different rating systems and rating system adaptations (U.S. Green Building Council, 2011)

LEED rating system is classified into different groups according to the unique needs and requirements of each project and building type. Its classifications include the three most famous groups of New Construction and Major Developments (which is most widely used), Existing Buildings Operations and Maintenance, Commercial Interiors, along with other groups for other project types including health facilities, schools, homes and even entire neighborhoods. All these LEED categories help projects to satisfy prerequisites, get points and achieve one level of LEED certification according to points obtained from LEED credit categories (https://new.usgbc.org) -which these main categories were discussed in previous section.

### 1.5.4. Malaysia Green Building Index (GBI)

Over the last twenty years, office buildings in all major cities of Malaysia have increased considerably in numbers, especially in Kuala Lumpur, as a federal capital of

the country (Shahriar, 2006). The Green Building Index is an environmental rating system for buildings developed in April 2009 by PAM (Pertubuhan Arkitek Malaysia / Malaysian Institute of Architects) and ACEM (the Association of Consulting Engineers Malaysia), and it is designed specifically for the Malaysian tropical weather, environmental and developmental context, cultural and social needs. GBI initiative in an attempt to direct Malaysia building industry toward sustainable development, created GBI environmental rating system in order to define green buildings by establishing a common language and standard of measurement; promote integrated, whole-building design; recognize and reward environmental leadership; transform the built environment to reduce its environmental impact; and to ensure new buildings remain relevant in the future and existing buildings are refurbished and upgraded properly to remain relevant (Green Building Index, 2009).

According to the Brundtland Commission on "Our Common Future" in 1987, United Nation World Commission on Economic Development, sustainability is defined as "choosing paths of social, economic, and political progress that meets the needs of the present without compromising the ability of future generation to meet their own needs". And the "triple bottom line" of sustainability includes: Environmental Stewardship, Social Responsibility, and Economic Prosperity. While designing green buildings which are essentially sustainable, these concepts should be applied to the whole life-cycle of the building in order to minimize the use of natural resources, energy, materials, and environmental effects of the site and the building itself, at the same time to enhance quality of life inside the building and maximize its positive impacts on the community.